

## 3.4 TOLERANCES

### a. General

The tolerances listed in this section shall be applied to all scales under the jurisdiction of the Service.

#### (1) Theory

It is understood that exact or errorless performance of weighing devices is unattainable. Uniform tolerances are therefore prescribed to allow permissible errors small enough to satisfy both buyer and seller and large enough so that both manufacturing and maintenance costs are not disproportionate. FGIS provides two sets of tolerances where necessary: "Acceptance" and "Maintenance" tolerances. Acceptance tolerances shall be applied to new installations and to installations where adjustments and/or modifications have taken place after official rejection or exceeding applicable tolerances. Maintenance tolerances provide an added range of "inaccuracy" (twice the value of acceptance tolerances) allowing for a limited amount of deterioration.

#### (2) Adjustments and Tolerances

When adjustments are made to scale systems they shall be made to bring the system as close to zero error as possible. Owners, operators, or repair persons shall not be allowed to adjust scale systems toward tolerance limits.

#### (3) Application and Uniformity

A weighing system may have errors in excess and/or deficiency. By application of "Approval Seals," (FGIS-9601, Approved Label for Inspected Machinery) the scale official certifies that the weighing system is accurate and errors, if any, are within acceptable tolerance limits.

(4) Design

The tolerance for a weighing device is a performance requirement independent of the design principle used. (H-44, 1994, T.N.1.1.)

(5) Accuracy Classes

Weighing devices are divided into accuracy classes according to the number of scale divisions (n) and the value of each scale division (d). (H-44, 1994, T.N.1.2.)

(6) Scale Division

The tolerance of a weighing device is related to the scale division (d) or the value of the verification division (e) and is generally expressed in terms of d or e. (H-44, 1994, T.N.1.3.)

**b. Tolerance Application**

(1) General

The tolerance values are positive (+) and negative (-) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference; the tolerance values apply to certified test loads only. (H-44, 1994, T.N.2.1.)

(2) Multi-Range (Variable Division-Value) Scales

For multi-range devices, the tolerance values are based on the value of the scale division of the range in use. (H-44, 1994, T.N.2.4.)

**c. Basic and Minimum Tolerance**

(1) General

The basic tolerance includes both acceptance and maintenance tolerances. Where these tolerances provide an allowable error too small to be applicable, the minimum tolerance value shall apply. The minimum tolerance is the smallest allowable error that can be applied to any scale or weighing system.

WEIGHING HANDBOOK  
CHAPTER 3  
3.4 TOLERANCES  
9/20/96

(2) Minimum Tolerance for Scales That are not Under a Class Tolerance Application

When not otherwise specified the minimum tolerance to be applied shall be 0.05% (1/2000) of scale capacity or one-half "d" whichever is less. (H-44, 1994, T.1.1.3.)

(3) Minimum Tolerance for Automatic Bulk Weighing Scales

The minimum tolerance value shall not be less than half the value of the scale division. (H-44, 1994, T.2. ABWS Code)

(4) Tolerances for Scales not Marked with an Accuracy Class, Except for Automatic Bulk Weighing Scales, and Grain Test Scales

Paragraphs d. (4); e. (3) (a); e. (6) (a), (b), (c); and, e. (10) of this section also apply. (H-44, 1994, T.1.1. in part)

Table 11 Tolerances for Unmarked Scales					
Type of Device	Subcategory	Min. Tol.	Accept Tol.	Maint. Tol.	Decreasing Load Multiplier <sup>1</sup>
Vehicle, railway track (weighing statically)		Maint. Tol. as shown in Table 13, Accept. Tol ½ values in Table 13.			1.0
All other scales	n > 5,000	0.5 d or 0.05% of scale capacity, whichever is less	0.05% of test load	0.1 % of test load	1.5
	n ≤ 5,000	Maint. Tol. as shown in Table 13, Accept. Tol ½ values in Table 13.			1.0

<sup>1</sup>The decreasing load test applies only to automatic indicating scales.

(5) Tolerances for Grain Test Scales That are not Marked with an Accuracy Class According to Specific Use

Table 12 Tolerances for Unmarked Grain Test Scales				
Type	Usage	Tolerance	Sensitivity Requirement	Shift Tolerance
Precision	Samples less than equal to 120 g	.02 g	.01 g	.02 g
Moisture	Moisture portions from 150 g to 300 g	.2 g	.1 g	.2 g
General	Samples greater than 120 g other than moisture portions	1 g	1 g	1 g

(6) Tolerances for Scales Marked with an Accuracy Class, Except for Automatic Bulk Weighing Scales

(a) Maintenance Tolerances

Table 13 Tolerances for Scales Marked with an Accuracy Class

Maintenance Tolerances (All values in this table are in scale divisions)				
Tolerance in scale divisions				
	±1	±2	±3	±5
Class	Test Load			
II	0 - 5 000	5 001 - 20 000	20 001 +	
III	0 - 500	501 - 2 000	2 001 - 4 000	4 001 +
III L	0 - 500	501 - 1 000	(Add 1d for each additional 500d or fraction thereof)	

(H-44, 1994, T.N.3.1. in part)

(b) Acceptance Tolerance Values

The acceptance tolerance values shall be one-half the maintenance tolerance values. (H-44, 1994, T.N.3.2.)

(7) Tolerances for Automatic Bulk Weighing Scales

The basic maintenance tolerance shall be one pound per 1,000 pounds of test load (0.1 percent). The basic acceptance tolerance shall be one-half the basic maintenance tolerance. (H-44, 1994, T.3. ABWS Code, in part)

(8) Accumulated Error During Increasing Load Tests on Automatic Bulk Weighing Scales

The buildup test on electronic/levertronic hopper scales shall involve the substitution of material (grain) for known test weights in increments not to exceed the value of the test weights. At each step the error shall not exceed the applicable tolerance applied to the known test weights and the accumulated error shall not exceed the applicable tolerance applied to the total load (grain + test weights). The accumulated error shall be determined by the addition (algebraic sum) of individual step errors.

(9) Tolerances for All Vehicle and Railway Track Scales

The maintenance and acceptance tolerances shall be those for Class III L scales as listed in Item (6) (Table 13).

(H-44, 1994, T.N.3.1., T.N.3.2.)

**d. Sensitivity and Discrimination Requirements**

(1) Sensitivity Requirement (SR) for Nonautomatic-Indicating Scales not Marked with an Accuracy Class

(a) Application.

The sensitivity requirement (SR) is applicable to all nonautomatic-indicating scales not marked II, III, or III L, and is the same whether acceptance or maintenance tolerances apply. (H-44, 1994, T.2.1. in part)

(b) SR for Hopper Scales and Commodity Scales

2d, 0.2 percent of the scale capacity, or 40 pounds, whichever is least. (H-44, 1994, T.2.2. in part)

(c) SR for Grain Test Scales. 1d or 0.2 percent of the scale capacity, whichever is less. (H-44, 1994, T.2.6.)

(d) SR for Vehicle Scales.

1) Equipped with balance indicators - 1d.

2) Not equipped with balance indicators: 2d or 0.2 percent of the scale capacity, whichever is less. (H-44, 1994, T.2.7.)

(e) SR for Railway Track Scales

3d or 100 pounds, whichever is less. (H-44, 1994, T.2.8.)

(f) Sensitivity Requirements, Equilibrium Change Required

The minimum change shall be:

1) Scale with a Trig Loop but Without a Balance Indicator

The position of rest of the weighbeam shall change from the center of the trig loop to the top or bottom, as the case may be.

2) Scale With a Single Balance Indicator and Having a Nominal Capacity of Less Than 500 Pounds

The position of rest of a single indicator on a scale having a nominal capacity of less than 500 pounds shall change at least 0.04 inch or at least one division on the graduated scale, whichever is greater.

3) Scale With a Single Balance Indicator and Having a Nominal Capacity of 500 Pounds or Greater

The position of rest of a single indicator on a scale having a nominal capacity of 500 pounds or greater shall change at least 0.25 (1/4) inch or one division on the graduated scale or

the width of the central target area, whichever is greater. However, the indicator on a batching scale shall change at least 0.125 ( $\frac{1}{8}$ ) inch or one division on the graduated scale, whichever is greater.

4) Scale with Two Opposite-Moving Balance Indicators

The position of rest of the two indicators moving in opposite directions shall change 0.04 inch with respect to each other.

5) Scale with Neither a Trig Loop Nor a Balance Indicator

The position of rest of the weighbeam or lever system shall change from the horizontal, or midway between limiting stops, to either limit of motion.

(H-44, 1994, T.3. in part)

(2) Test Load for Nonautomatic-Indicating Scales Marked With an Accuracy Class

This subsection is applicable to nonautomatic-indicating scales marked II, III, or III L.

(a) The test load for sensitivity for nonautomatic-indicating vehicle scales shall be 1d for scales equipped with balance indicators, and 2d or 0.2 percent of the scale capacity, whichever is less, for scales not equipped with balance indicators.

(b) For all other nonautomatic-indicating scales, the test load for sensitivity shall be 1d at zero and 2d at maximum test load. (H-44, 1994, T.N.6.1. in part)

(3) Minimum Change of Indications for Nonautomatic-Indicating Scales Marked With an Accuracy Class

This subsection is applicable to nonautomatic-indicating scales marked II,

III, or III L. The addition or removal of the test load for sensitivity shall cause a minimum permanent change as follows.

- (a) For a scale with trig loop but without a balance indicator, the position of the weighbeam shall change from the center to the outer limit of the trig loop.
- (b) For a scale with a balance indicator, the position of the indicator shall change one division on the graduated scale, the width of the central target area, or the value as follows, whichever is greater.
  - 1) Class II scale: 0.04 inch (1 mm).
  - 2) Class III scale with a maximum capacity of 70 pounds (30 kg) or less: 0.08 inch (2 mm).
  - 3) Class III or III L scales with a maximum capacity of more than 70 pounds (30 kg): 0.20 inch (5 mm).
- (c) For a scale without a trig loop or balance indicator, the position of rest of the weighbeam or lever system shall change from the horizontal or midway between limiting stops to either limit of motion.

(H-44, 1994, T.N.6.2. in part)

- (4) Discrimination Requirement for Digital Automatic-Indicating Weighing Scales

A test load equivalent to 1.4d shall cause a change in the indicated or recorded value of at least two divisions. This requires that the zone of uncertainty shall not be greater than 0.3 times the value of the scale division. (H-44, 1994, T.N.7.2.)

- (5) Discrimination Requirement for Analog Automatic-Indicating Scales (i.e., Weighing Device with Dial, Drum, Fan, etc.)

A test load equivalent to 1.4d shall cause a change in the indication of at least 1.0d. (H-44, 1994, T.N.7.1. in part)



- (6) Separate Main Element Requirement for Scales Marked with an Accuracy Class: Load Transmitting Element, Indicating Element, etc.

If a main element separate from a weighing device is submitted for type evaluation, the tolerance for the element is no more than 0.7 times that for the complete weighing device. This fraction includes the tolerance attributable to the testing devices used. (H-44, 1994, T.N.3.5.)

**e. Tolerance Applications**

- (1) Acceptance Tolerance

Acceptance tolerances shall be applied as follows.

- (a) To any equipment about to be put into official use for the first time.
- (b) To equipment that has been placed in official service within the preceding 30 days and is being officially tested for the first time.
- (c) To equipment that has been returned to official service following official rejection for failure to conform to performance requirements and is being officially tested for the first time within 30 days after corrective service.
- (d) To equipment being officially tested for the first time within 30 days after major reconditioning or overhaul.
- (e) To equipment undergoing type evaluation.

(H-44, 1994, G-T.1.)

- (2) Maintenance Tolerance

Maintenance tolerances shall apply to equipment in actual use, except as provided for under "Acceptance Tolerance." (H-44, 1994, G-T.2. in part)

(3) Repeatability of Test Load Indications

(a) Static Conditions

The results obtained under reasonably static test conditions, by several weighings of the same load, shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances. (H-44, 1994, T.N.5.)

(b) Zero-load Balance Change

A zero-load balance change test shall be conducted on all scales after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (H-44, 1994, N.1.9.)

(4) Excess and Deficiency

Tolerances "in excess" and tolerances "in deficiency" shall apply to errors in excess and to errors in deficiency, respectively. (H-44, 1994, G-T.3. in part)

(5) Scales That are not Marked With an Accuracy Class Involving Digital Indications or Representations

To the tolerances that would otherwise be applied, there shall be added an amount equal to one-half the minimum value that can be indicated or recorded. This does not apply to digital indications or recorded representations that have been corrected for rounding error using error weights. (H-44, 1994 T.1.1.2)

(6) Agreement of Indications

(a) Multiple Indicating/Recording Elements

In the case of a scale or weighing system equipped with more than one indicating element or indicating element and recording element combination, where the indicators or indicator/recorder combination are intended to be used independently of one another, tolerances shall be applied independently to each indicator or indicator/recorder combination. (H-44, 1994, T.N.4.1.)

(b) Single Indicating/Recording Element

In the case of a scale or weighing system with a single indicating element or an indicating/recording element combination, and equipped with component parts such as unit weights, weighbeam and weights, or multiple weighbeams that can be used in combination to indicate a weight, the difference in weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load, and shall be within tolerance limits. (H-44, 1994, T.N.4.2.)

(c) Single Indicating Element/Multiple Indications

In the case of a analog indicating element equipped with two or more indicating means within the same element, the difference in weight indications for any load other than zero shall not be greater than one-half the value of the scale division (d) and be within tolerance limits. (H-44, 1994, T.N.4.3.)

(7) Time Dependence

At constant test conditions, the indication 20 seconds after the application of a load, and the indication after 1 hour shall not differ by more than:

- (a) one half of the absolute value of the applicable tolerance for the applied load for class III L devices; and
- (b) the absolute value of the applicable tolerance for the applied load for all other devices. (H-44, 1994, T.N.4.5.)

(8) Shift or Section Tests

The range of the results obtained during the conduct of a shift test or a section test shall not exceed the absolute value of the maintenance tolerance applicable and each test shall be within applicable tolerances. (H-44, 1994, T.N.4.4.)

(9) Ratio Tests

For ratio tests the tolerance values are .75 of the applicable tolerances.  
(H-44, 1994, T.N.2.5. in part)

(10) Railway Track Scales Weighing Uncoupled-in-Motion Cars

The basic maintenance and acceptance tolerance shall be the same as the static weighing basic tolerances for railway track scales.

**f. Influence Factors**

(1) Applicability

The following factors are applicable to tests conducted under controlled conditions only, provided that:

- (a) Types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section, and
- (b) New types of devices submitted for approval after January 1, 1986, shall comply with the requirements of this section, and
- (c) All devices manufactured after January 1, 1988, shall comply with the requirements of this section.

(H-44, 1994, T.N.8.)

(2) Temperature

Devices shall satisfy the tolerance requirements under the following temperature conditions.

- (a) If not specified in the operating instructions for Class II scales, or if not marked on the device for Class III or III L scales, the temperature limits shall be:

14°F to 104°F (-10°C to 40°C)

(H-44, 1994, T.N.8.1.1)

- (b) If temperature limits are specified for the device, the range shall be at least:

Temperature Range by Class	
Class	Temperature Range
II	27°F (15°C)
III, IIIL	54°F (30°C)

(H-44, 1994, T.N.8.1.2.)

- (c) The zero-load indication shall not vary by more than 1 division per 9°F (5°C) change in temperature. (H-44, 1994, T.N.8.1.3.)
- (d) Except for Class II devices, an indicating or recording element shall not display or record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition has been attained. (H-44, 1994, T.N.8.1.4.)
- (e) An indicating or recording element shall not display or record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition has been attained. (H-44, 1994, T.5.)

(3) Electric Power Supply

- (a) Power Supply, Voltage, and Frequency.
- 1) Weighing devices that operate using alternating current must perform within the established conditions inclusive over the line voltage range of 100 - 130 volts or 200-250 volts rms as appropriate and over the frequency range of 59.5 to 60.5 Hz.

- 2) Battery operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient. (H-44, 1994, T.N.8.3.1.)

(b) Power Interruption

A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits. (H-44, 1994, T.N.8.3.2.)

(4) Barometric Pressure

The zero indication shall not vary by more than 1 scale division for a change in barometric pressure of 1 kilopascal over the total barometric pressure range of 95 to 105 kilopascals (28 to 31 inches of Hg.). (H-44, 1994, T.N.8.2. in part)

(5) RFI Susceptibility Tests, Field Evaluation

An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered "usual and customary." (H-44, 1994, N.1.6.)